September 1943

UNITED STATES DEPARTMENT OF AGRICULTURE
Food Distribution Administration

In cooperation with

CLEMSON AGRICULTURAL COLLEGE

EFFECT OF CARD SPEEDS AND PRODUCTION RATES ON THE QUALITY OF YARN MANUFACTURED FROM VARIOUS GRADES OF COTTON

By

John M. Cook and A. Y. Willis, Jr., Cotton Technologists,
Food Distribution Administration

CONTENTS

PURPOSE OF TEST

Supplies of better grades of cotton are depleted because of the heavy demand for high-quality textiles by the armed services and the decrease in production of high grades during recent years. At the same time there is a surplus of the lower grades. In view of this situation, cotton mills are likely to find it necessary to utilize lower grades in the manufacture of yarns and fabrics which customarily have been made from the better grades of cotton.

The test upon which this report is based was made to ascertain the extent to which certain changes in mill cleaning processes could be varied so as to utilize more of the low grades without substantially affecting card production, yarn appearance, and yarn strength. Little information has been available regarding the extent to which yarn

quality is affected by changing card cylinder and licker-in speeds while the production rate is held constant. In a recent card test, Dunlap 1/ found that yarn quality as reflected by appearance grades and skein strengths was not appreciably affected when all moving parts of the card were speeded up by approximately 15 percent, but no information was reported on the effects of relative changes in the speeds of certain cleaning parts. The test results reported herein show the effects on yarn quality of speeding up the cleaning parts of the card while the feed and rate of production are unchanged. These results are shown for five different production rates on each of five grades of cotton.

TESTING PROCEDURE

Five bales of cotton grown in a one-variety production area of the Mississippi Delta were selected for this manufacturing test. The bales, representing a wide range of grades, were classified by the Appeal Board of Review Examiners in Washington as: Good Middling grade, 1-3/32 inches staple; Middling Spot (light), 1-1/16 inches; Low Middling Bright, 1-1/16 inches; Low Middling, 1-1/32 inches; Middling Gray, 1-1/16 inches. Except for the Low Middling bale which was called "Soft," all cottons in the test were considered by the classers to have normal character for the grades assigned.

Ten representative samples were made up from each bale and processed through the breaker and finisher pickers. Settings of the pickers were based on trial tests made on several samples taken from the Low Middling Bright bale. The settings shown in table 1 were used as they gave a reasonably clean lap without removing too much good fiber. In addition to the laps mentioned above, a lap of Good Middling and two laps of Middling Gray were given a very severe picker treatment by increasing the beater blows per inch.

Laps from each bale were carded at 8, 10, 12, 14, and 16 revolutions per minute of the doffer which produced approximately 7.8, 9.8, 11.8, 13.7 and 15.7 pounds of 45 grain sliver per hour respectively, with no allowance for stoppages. Each increase in doffer speed was accompanied by a proportionate increase in the speed of the feed roll. A cylinder speed of 168 r.p.m. and a licker-in speed of 420 r.p.m. was used for one series of five laps. A second series of laps was carded at the same doffer speeds but with the cylinder speed increased to 199 r.p.m. and the licker-in to 500 r.p.m. Settings used on the opener, pickers, and card are shown in table 1. Samples of card web totaling 360 square inches were taken intermittently from each test lot and examined to determine the average number of neps per 100 square inches. The percentage of manufacturing waste removed at the cleaning processes was carefully determined for each test lot.

1/ Dunlap, G. H., "Comparative Test of Cottons Manufactured under Normal and High Card Cylinder Speeds on Cards Equipped with Metallic Clothing." (Mimeographed.) (Also published in March 15, 1942, issue of Textile Bulletin.)

Table 1.- Settings used on opener, pickers, and card .

Machine	Settings	
Vertical opener	Grid from beater, top	1 inch
	Grid from beater, bottom	7/8 inch
Breaker picker	Feed roll to beater	3/16 inch
	Grid from beater, top and bottom	1/2 inch
Finisher picker	Feed roll to beater	3/16 inch
	Grid from beater, top	5/16 inch
	Grid from beater, bottom	11/16 inch
Card	Feed plate to licker-in	10 gauge
	Mote knives to licker-in, top	15 gauge
	Mote knives to licker-in, bottom	12 gauge
	Licker-in to cylinder	7 gauge
	Back plate to cylinder, top	29 gauge
	Back plate to cylinder, bottom	34 gauge
	Flats to cylinder, back, center, and front	9 gauge
	Front plate to cylinder, top	29 gauge
	Front plate to cylinder, bottom	34 gauge
	Doffer to cylinder	7 gauge
	Doffer comb to doffer	22 gauge
	Licker-in screen, front	29 gauge
	Licker-in screen, back	1/16 inch
	Cylinder screen, back	29 gauge
	Cylinder screen, center	34 gauge
	Cylinder screen, front	3/16 inch

The weight of the stock made at each process, number of doublings, and drafts are shown in figure 1. Roving processes were carried out on regular draft frames and long draft spinning was employed. All manufacturing was done on standard commercial equipment in relative humidities of approximately 50 percent in the picker room, 60 percent in the card room, and 70 percent in the spinning room. Tests to determine yarn and fiber properties were made under standard atmospheric conditions of 65 percent relative humidity and 70° Fahrenheit.

Each of the 53 lots was spun into carded 20s, 30s, and 40s single warp yarns. Twist multipliers, calculated to give the strongest yarns by the skein test, were selected on the basis of the staple length of each bale. A portion of each count of yarn from all spinning lots was graded for appearance in accordance with the yarn standards developed by the U. S. Department of Agriculture in cooperation with the American Society for Testing Materials.

Breaker picker	Finisher picker	Card	First drawing	Second drawing	Slubber	Inter-mediate	Spinning
	Doubling 4	Doubling 1	Doubling 6	Doubling 6	Doubling 1	Doubling 2	Doubling 2
						3.15 hanks	20s yarn
						(6.00)	(12.70)
15 ounces	12 ounces	45 grains	42.5 grains	40 grains	1.05 hanks		30s yarn
	(5.00)	(116.7)	(6.35)	(6.38)	(5.04)		(19.05)
						4.00 hanks	40s yarn
						(7.62)	(20.00)

Figure 1.- Size of stock made and doublings at each manufacturing process. Figures in parentheses show nominal drafts used.

Fiber properties of raw cotton samples are frequently useful in explaining yarn appearance, strength, and other manufacturing qualities. Therefore, physical tests on each spinning lot were made to determine fiber length by the array method, length variability, and the fiber strength of both bale and card sliver samples. Fiber fineness and the percentage of thin-walled fibers were also determined on bale samples in accordance with standard laboratory methods. Because differences between spinning lots of the same grades were not significant, results of fiber tests on the 10 lots of each grade were averaged.

TEST RESULTS

Yarn Appearance

Yarn appearance is an important factor in determining the value of finished textile products and one that is directly affected by increased card production. Before substitutions of lower grades of cotton are made, the manufacturer must necessarily consider the extent to which yarn appearance will be affected by the use of lower grades. Also to be considered is the possibility of varying the cleaning processes to compensate for the larger amounts of foreign matter

present in lower grades. To obtain information regarding the effects of card speed changes on yarn appearance, 20s, 30s, and 40s yarns were spun from cottons carded at different cylinder and doffer speeds and were graded for appearance.

Results of the yarn grading have been summarized and are presented in figure 2. Note that yarns became progressively poorer in appearance as lower grades of cotton were used. The chart also shows that yarns of slightly better appearance were made when the card cylinder speed was increased from 168 to 199 r.p.m. Some improvement in yarn appearance was gained by increasing the speeds of certain working parts of the card without changing the production. This improvement, however, was in no instance sufficient to permit the substitution of a lower grade of raw cotton and at the same time fully maintain yarn appearance.

A visual inspection of the yarns for color showed definite graduations in brightness ranging from the very bright yarns made of Good Middling to the dark yarns made of Middling Gray grade. The three better grades made yarns having excellent color for their respective grades, yarns made from Low Middling were considerably duller, and those made from the Middling Gray bale were quite dark and discolored.

When card production was increased progressively by speeding up the doffer from 8 to 16 r.p.m., it was found that, in general, the appearance of yarns made from a given grade of cotton became rougher. Average yarn appearance for the test lots of all grades carded at different production rates are shown in figure 3. This figure shows that when the cylinder was run at 199 r.p.m., the resulting yarns were better in appearance at all comparable doffer speeds with the exception of 16 r.p.m. of the doffer, in which case a small but not significant difference favored the slower cylinder speed. The figure also shows that when the doffer speed was increased from 10 to 12 r.p.m. with a cylinder speed of 168 r.p.m. the yarns became significantly rougher, while at a cylinder speed of 199 r.p.m. the first appreciable increase in roughness of the yarns occurred when the doffer speed was increased from 12 to 14 r.p.m.

A count of neps in the card web for each test lot revealed that in general the differences in neppiness between grades was greater than between lots carded at different cylinder speeds. Results of the nep counts for each test lot are shown in table 2.

As the speed of the doffer was increased from 8 to 16 r.p.m., the number of neps per 100 square inches of web was almost doubled. This increase in neppiness was, therefore, greater than might be expected on the basis of yarn appearance grade results. For a given cylinder speed, less thorough carding was done at the higher rates of production, but in general the greater card cylinder speed removed more waste and resulted in better-appearing yarns.

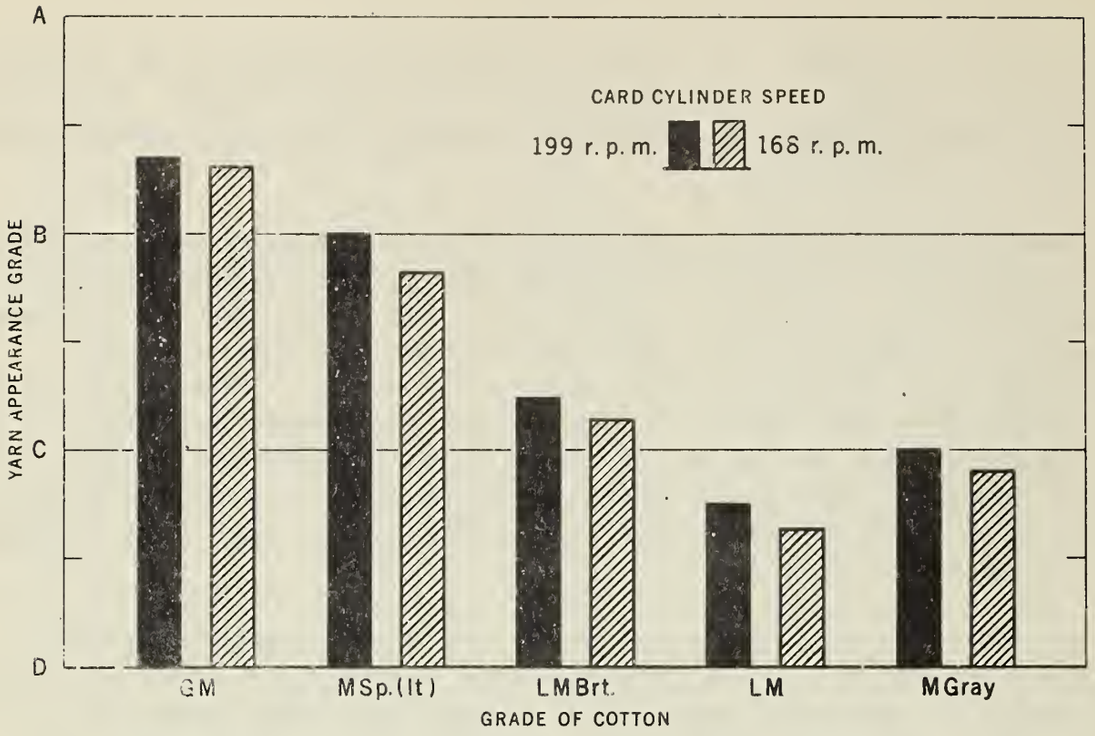

Figure 2.- Appearance grades of yarns manufactured from specified grades of cotton, and carded at two cylinder speeds. Each bar represents the average grade of 3 counts of yarn made from each of 5 lots. Yarn grades range downward from "A" for excellent to "D" for very rough appearance. Note that higher grades of cotton and the greater card cylinder speed made yarns of better appearance.

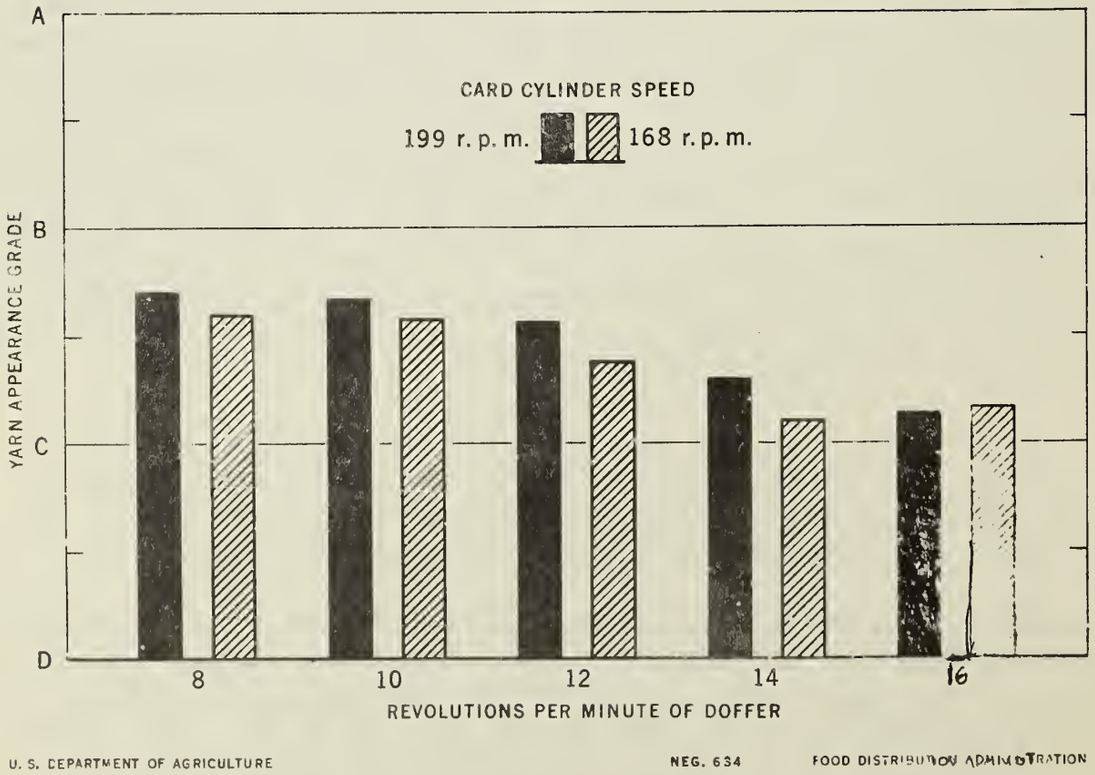

Figure 3.- Average appearance grades of yarns manufactured from 5 grades of cotton carded at specified doffer and cylinder speeds. Note the decrease in yarn appearance that takes place with each increase of doffer speed, and the better yarn appearance when the cylinder was run at 199 r. p. m.

Table 2. - Neps per 100 square inches of card web made from different grades of cotton when carded at two cylinder speeds and specified doffer speeds 1/

Cylinder and doffer speeds	Good Middling	Middling Spot (light)	Low Middling Bright	Low Middling	Middling Gray	Average
R.P.M.	Number	Number	Number	Number	Number	Number
Cylinder 168						
Doffer:						
8	9	20	47	74	53	41
10	18	25	50	79	47	44
12	21	29	72	66	52	48
14	17	39	96	87	53	58
16	21	35	100	137	68	72
Average	17	30	73	89	55	53
Cylinder 199						
Doffer:						
8	12	18	48	50	42	34
10	12	23	54	94	48	46
12	14	21	58	77	57	45
14	20	34	62	94	81	58
16	14	46	79	105	99	69
Average	14	28	60	84	65	50

1/ Each value is based on a count of the neps in 360 square inches of card web.

Table 3. - Fiber properties of five grades of cotton used in this test

Grade of cotton	Length 1/			Weight per inch 2/	Thin-walled fibers 2/	Tensile strength per sq. inch 2/
	Upper quartile	Mean	Coefficient of variation			
	Inches	Inches	Percent	Micrograms	Percent	1,000 lbs.
Good Middling	1.239	1.034	28	4.60	20	71.5
Middling Spot (light)	1.187	.933	35	4.60	22	74.3
Low Middling Bright	1.219	.960	35	3.81	31	72.4
Low Middling	1.221	.937	38	3.47	40	73.6
Middling Gray	1.190	.897	40	3.98	33	71.1

1/ Average values of 20 length arrays.
2/ Average value of 10 complete tests.

Thin-walled or immature fibers are objectionable in raw cotton samples as they are known to be a source of neps. A comparison of the percentage of immature fibers reported in table 3 with the yarn appearance grades (fig. 2) shows that yarn appearance decreased as the percentage of thin-walled fibers increased. A reference to table 2 shows that card web neppiness increased rapidly as percentages of thin-walled fibers in the raw cotton became larger. The differences in fiber weight per inch shown in table 3 are rather large for samples having approximately the same length, but these are attributable to large differences in the percentages of thin-walled or undeveloped fibers. The excessive percentage of thin-walled fibers in the Low Middling sample was recognized by the classers when they called it "soft."

Results of this test indicate that when doffer speeds of 12 r.p.m., or greater, are used on cottons of these approximate lengths, it may be advisable to run the card cylinder at a greater-than-normal speed in order to obtain better yarn appearance grades. Other factors, such as the mechanical condition of the card and its foundation, would, of course, have to be considered before increasing cylinder speeds. The card used in the spinning laboratory was a standard type and showed no ill effects as a result of being run at a cylinder speed of 199 r.p.m. Dunlap 2/ suggests that high card speeds be tried with caution but states that, in general, mill experiments have upheld the practicability of operating cards at high speeds.

A lap made from Good Middling and two from Middling Gray cotton were given from 50 to 100 percent more than normal beating at the picker processes by increasing the blows per inch of the beater from 25 to 39 at the breaker and from 55 to 90 at the finisher. The Good Middling lap subjected to this greater beater speed produced poorer-appearing yarns than the comparable lap that received normal treatment. Laps made from the Middling Gray cotton were manufactured into yarns that were approximately equal in appearance to those spun from comparable laps receiving normal picker treatment. Results for this phase of the test are limited but they indicate that no improvement is to be expected from subjecting very low-grade cottons of the lengths used in these tests to more beating in the pickers. Severe beating at the pickers lowered the quality of yarn made from the Good Middling cotton.

Yarn Strength

Yarn strength is generally recognized in the textile industry as an important factor in manufacturing efficiency and one that contributes to the serviceability and utility of finished products. Therefore, it is desirable to consider the effects that greater card cylinder speed and card production have on yarn strength.

2/ Dunlap, George H. Additional tests indicate the practicability of increased card speeds. Textile Research, XII, No. 8, June 1942.

Skein tests were made on each of the three yarn counts spun from the 53 spinning test lots to determine the effects on yarn strength of various card speeds. Results of these tests for the 50 lots that were given the same picker treatment are shown in table 4. No significant differences in yarn strength were found between the three lots given more cleaning at the picker and those given normal picker treatment. Yarn skein strength data reported for this test are based on an average of 25 breaks for 20s and on 35 breaks for 30s and 40s yarns as previous tests have shown that fewer breaks on the coarser counts are required to maintain a given level of significance. The practice followed at the spinning laboratory is to make a sufficiently large number of skein breaks to keep the results within 2 percent of the true mean.

The skein strengths reported show that the strongest yarns were made from Low Middling grade, followed by Good Middling, Low Middling Bright, Middling Spot (light), and Middling Gray respectively. Because of the differences in fiber length and in other properties, detailed comparisons of yarns spun from the different grades will not be undertaken in this report. It appears, however, that the substitution of lower grades of cotton for higher grades could be made without sacrificing yarn strength. This observation does not include the Middling Gray bale which, of course, showed up poorly as a result of having been weather damaged before harvesting.

Fiber length and tensile strength are useful fiber properties in predicting the strength of yarn that may be expected from a given cotton. Cottons in this study were grown in the same locality and planted from the same seed stocks, so differences with respect to strength and upper quartile length were relatively small. The stronger yarns were spun from the Low Middling and Good Middling grades. Inspection of fiber length and strength data in table 3 indicates that the good yarn strength of the Low Middling bale may be attributable to a combination of length, fineness, and fiber strength and that of the Good Middling sample may be accounted for by its greater fiber length. Attention is called to the fact that although thin-walled fibers may be expected to contribute to yarn strength, they are objectionable as a source of neps. The Low Middling Bright was intermediate in yarn strength and approximately so with respect to length and fiber strength. The bale of Middling Spot (light) had the best fiber strength, but this did not offset its shorter fiber length. Yarns spun from the Middling Gray bale were the weakest and fiber properties were, as a whole, the poorest of the five bales.

An analysis of the yarn strength data for a given grade shows no significant differences between lots carded at different doffer speeds, but on the average it was found that slightly stronger yarns were spun from cottons carded at a cylinder speed of 199 r.p.m. While this trend held true for all grades and doffer speeds, the more rapid cylinder speed resulted in less than 0.6 percent stronger yarns, a

Table 4. - Skein strengths of carded yarns spun from specified grades of cotton carded at different cylinder and doffer speeds

Yarn size and grade of cotton 1/	Yarn skein strength 2/									
	Cylinder speed: 168 r.p.m. 3/					Cylinder speed: 199 r.p.m. 4/				
	Doffer speeds (r.p.m.)					Doffer speeds (r.p.m.)				
	8	10	12	14	16	8	10	12	14	16
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
20s yarn:										
Good Middling	136.3	132.5	136.3	136.3	134.6	136.6	135.6	134.9	134.6	133.9
Middling Sp.(light)	128.6	137.1	127.4	126.8	127.4	129.4	126.6	128.2	127.0	124.6
Low Middling Bright	127.0	127.2	126.9	126.7	125.7	128.3	129.7	129.6	127.8	130.3
Low Middling	131.8	136.5	134.3	134.2	132.7	135.6	134.5	135.3	133.4	143.3
Middling Gray	121.1	120.8	119.2	118.7	119.8	122.1	121.4	120.8	118.7	121.0
30s yarn:										
Good Middling	82.4	82.3	82.4	81.6	80.8	81.5	81.6	82.9	81.7	82.8
Middling Sp.(light)	75.9	77.7	77.1	77.2	77.2	78.5	76.8	77.8	78.6	76.0
Low Middling Bright	78.3	78.0	77.1	76.1	77.5	79.9	79.8	78.7	79.4	79.8
Low Middling	81.7	82.3	82.3	83.4	82.0	83.5	81.9	82.5	83.2	83.9
Middling Gray	74.7	72.7	74.9	75.5	74.9	76.1	74.1	74.2	74.6	75.2
40s yarn:										
Good Middling	57.7	58.1	57.2	56.3	57.3	57.3	57.7	56.1	57.5	57.1
Middling Sp.(light)	53.6	53.9	53.5	53.2	53.6	54.7	53.5	53.5	53.5	54.6
Low Middling Bright	56.9	55.1	56.9	56.2	54.9	56.4	55.6	56.2	54.6	55.9
Low Middling	58.9	59.0	58.7	59.3	58.7	58.4	58.6	59.9	57.8	58.2
Middling Gray	53.0	52.2	51.7	53.0	52.3	53.2	52.4	53.0	52.9	52.4

1/ Staple lengths: GM, 1-3/32; MSp(light), 1-1/16; LM Bright, 1-1/16; LM, 1-1/32 and MG 1-1/16 inches.
2/ Average of 25 breaks for 20s count of yarn, and 35 for 30s and 40s.
3/ Speed of licker-in 420 r.p.m.
4/ Speed of licker-in 500 r.p.m.

difference too small to be of any practical significance. In view of the wide range of grades tested, it is concluded that neither rate of card production nor cylinder speed has any important effect on yarn strength.

Manufacturing Waste

Carding is the most important cleaning process in the manufacture of cotton yarns, so any changes in card speeds would normally be expected to affect yarn quality and the percentage of waste removed. Manufacturing waste affects production costs, so records of the waste removed from each lot were carefully kept for each cleaning process. The Good Middling bale had the least waste, followed in order by Middling Spot (light), Low Middling Bright, Middling Gray and Low Middling. Percentages of the various kinds of card waste as well as the total removed by all processes through the card are shown in table 5, for each of the 50 lots receiving the same picker treatment. Manufacturing waste, and to some extent yarn appearance, are adversely influenced by fiber length irregularity. It was not surprising, therefore, to find a downward trend in yarn grades and an upward trend in manufacturing wastes as fiber length coefficients of variation became larger. (See table 3.)

More cotton is present between the cylinder and the flats and screen when production is increased by greater doffer and feed roll speeds, and when cylinder speeds are reduced without changing the rate of production. Less waste is removed under these conditions because the cotton is subjected to less carding action. The results reported in table 5 show that the reduction in card waste consists almost entirely of flat strips and of motes and fly. Results of the different doffer speeds and both cylinder speeds on the card waste, when averaged for all grades, are shown graphically in figure 4. The figure shows that when production was increased by greater doffer speeds there was a decline in the percentage of card waste and, also, that the greater cylinder speed increased card waste.

No significant effect on card waste was found for the lot of Good Middling or the two lots of Middling Gray that were subjected to more than normal beating at the pickers. Total picker and card waste for these lots was somewhat above other spinning lots but this difference is accounted for by the greater percentages of picker waste.

Manufacturing Performance

Notes were made with regard to general manufacturing performance of each spinning lot as it was being processed. Neppiness of the card web was greater for the slower cylinder speed and increased progressively with higher rates of card production. No other appreciable difference was observed between spinning lots made from the same grade of cotton. An efficient job of cleaning was done on all samples at the card.

Table 5. - Percentages of visible manufacturing waste removed from specified grades

Grade of cotton and kind of waste	Waste percentage									
	Cylinder speed: 168 r.p.m. 1/					Cylinder speed: 199 r.p.m. 2/				
	Doffer speeds (r.p.m.)					Doffer speeds (r.p.m.)				
	8	10	12	14	16	8	10	12	14	16
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Good Middling										
Card:										
Flat strips	3.06	2.81	2.68	2.68	2.55	3.88	3.26	3.04	2.81	2.86
Cyl. & doffer strips	.80	.78	.94	1.03	1.09	.72	.83	.87	.83	1.07
Motes and fly	.80	.67	.65	.62	.43	.98	.80	.76	.72	.63
Sweepings	.14	.14	.13	.22	.13	.18	.18	.13	.22	.13
Total	4.80	4.40	4.40	4.55	4.20	5.76	5.07	4.80	4.58	4.69
Opener, pickers & card:										
Total 3/	8.31	7.66	7.72	7.84	7.53	9.13	8.30	8.01	7.90	8.07
Middling Spot (light)										
Card:										
Flat strips	3.48	3.08	2.95	2.81	2.86	3.62	3.66	3.28	3.06	2.83
Cyl. & doffer strips	.76	.69	.85	1.05	1.18	.65	.76	.85	.91	1.07
Motes and fly	1.07	1.09	1.00	.87	.80	1.72	1.27	1.16	.98	.80
Sweepings	.20	.16	.22	.20	.18	.22	.16	.22	.18	.18
Total	5.51	5.02	5.02	4.93	5.02	6.21	5.85	5.51	5.13	4.88
Opener, pickers & card:										
Total 3/	8.86	8.18	8.36	8.20	8.26	9.43	8.94	8.59	8.28	8.13
Low Middling Bright										
Card:										
Flat strips	4.37	3.37	3.12	2.90	2.86	4.60	4.00	3.84	3.44	3.35
Cyl. & doffer strips	.94	1.01	1.12	1.16	1.25	.85	.98	.98	1.14	1.00
Motes and fly	1.34	1.25	1.11	.98	.98	1.56	1.43	1.34	1.20	1.07
Sweepings	.18	.11	.27	.18	.16	.22	.20	.18	.20	.18
Total	6.83	5.74	5.62	5.22	5.25	7.23	6.61	6.34	5.89	5.60
Opener, pickers & card:										
Total 3/	11.77	10.82	10.63	10.35	10.27	12.94	11.65	11.37	10.98	10.69

See footnotes at end of table (continued)

Table 5. - Percentages of visible manufacturing waste removed from specified grades (continued)

Grade of cotton and kind of waste	Waste percentage									
	Cylinder speed: 168 r.p.m. 1/					Cylinder speed: 199 r.p.m. 2/				
	Doffer speeds (r.p.m.)					Doffer speeds (r.p.m.)				
	8	10	12	14	16	8	10	12	14	16
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Low Middling										
Card:										
Flat strips	4.20	3.74	3.46	3.21	2.98	5.16	4.22	4.17	3.56	3.22
Cyl. & doffer strips	.99	1.12	1.27	1.45	1.43	.95	1.09	1.26	1.39	1.54
Motes and fly	1.46	1.34	1.22	1.04	1.02	1.76	1.47	1.38	1.23	1.19
Sweepings	.17	.29	.17	.23	.23	.28	.23	.28	.17	.17
Total	6.82	6.49	6.12	5.93	5.66	8.15	7.01	7.09	6.35	6.34
Opener, Pickers & card Total 3/	13.93	13.09	12.84	12.77	12.49	14.62	13.99	14.02	12.83	13.03
Middling Gray										
Card:										
Flat strips	3.95	3.62	3.42	3.30	3.11	4.80	4.24	3.89	3.39	3.33
Cyl. & doffer strips	.95	1.06	1.27	1.31	1.46	.89	1.09	1.08	1.21	1.27
Motes and fly	1.53	1.37	1.29	1.13	1.09	1.91	1.61	1.44	1.21	1.21
Sweepings	.20	.22	.22	.25	.20	.19	.21	.22	.25	.25
Total	6.63	6.27	6.20	5.99	5.86	7.79	7.15	6.63	6.06	6.06
Opener, pickers & card Total 3/	12.35	11.97	12.10	11.84	12.00	13.47	12.91	12.89	12.35	11.91

1/ Speed of licker-in 420 r.p.m.
2/ Speed of licker-in 500 r.p.m.
3/ Based on weight of cotton fed to vertical opener.

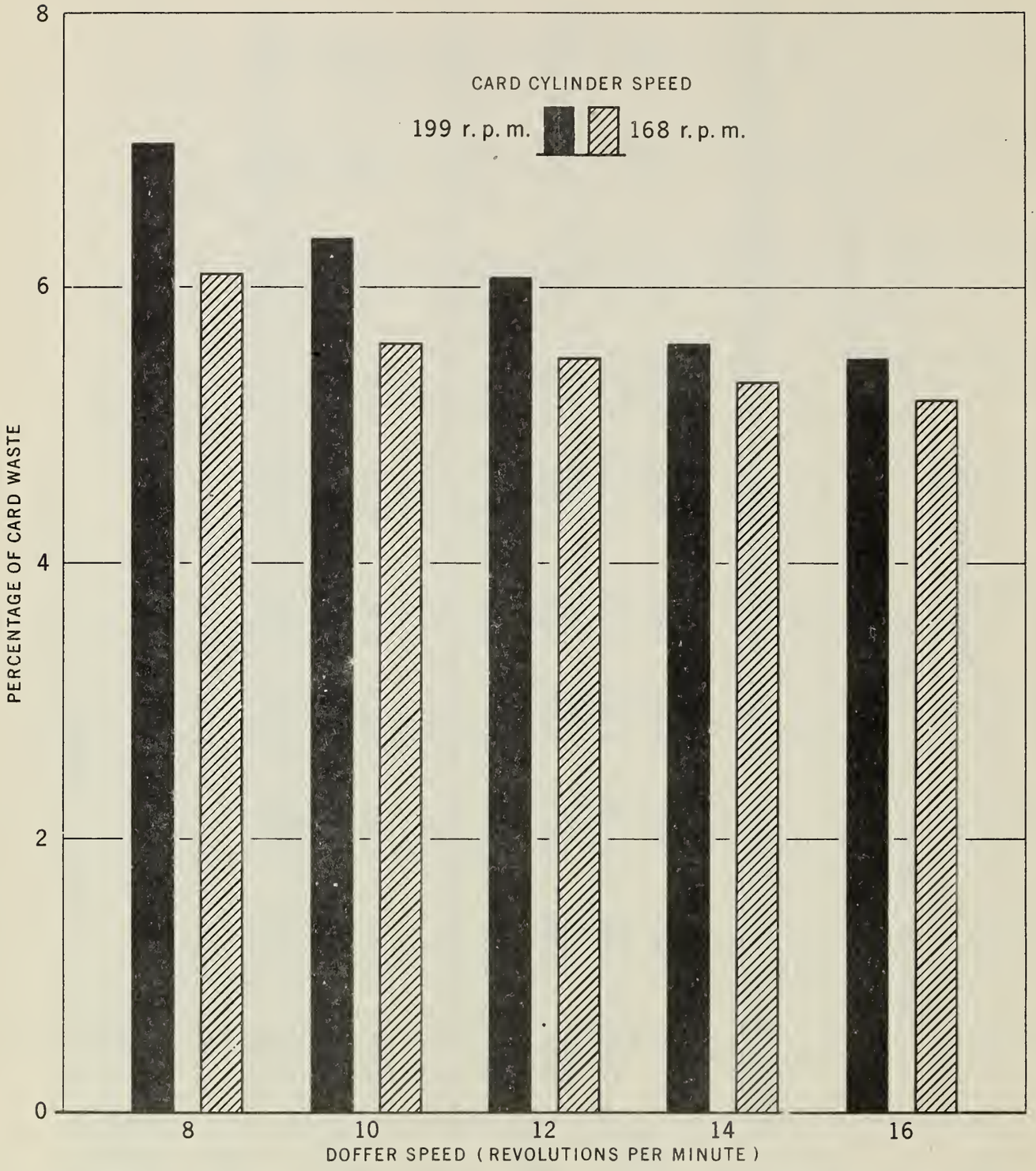

Figure 4.- Percentages of visible card waste removed when specified doffer speeds were used with each of two cylinder speeds. Each bar represents the average card waste of the five grades tested. Note the greater manufacturing waste when the cylinder was run at 199 r.p.m. and the decrease in waste as production was increased by greater doffer speeds.

Each lot of cotton was manufactured into 20s, 30s, and 40s yarns without difficulty so far as the actual machining was concerned, but the machines required about three times as much cleaning following the processing of Middling Gray or Low Middling grades as was required after processing the higher grades. Similarly, the dusty atmosphere made working conditions very uncomfortable during the processing of these grades. The unsatisfactory working conditions caused by dust and fly, the extra time required for cleaning, and the greater wear on machinery combine to offset a great deal of the difference in price between the higher and lower grades.

SUMMARY AND CONCLUSIONS

Supplies of better grades of cotton are being rapidly depleted as a result of the decline in production of higher grades and the heavy demands for high-quality goods needed by the armed services. Meanwhile, the surplus of low grades is becoming larger as a result of record crops of low grades for the past two years. This study was made to determine the practicability of varying card cylinder and doffer speeds in such a way that lower grades of cotton could be utilized without sacrificing yarn quality or card production.

Five bales of cotton ranging in grade from Good Middling to Low Middling, and including Middling Gray, were selected from a one-variety area in Mississippi for the study. Staple-length differences between the bales were small, ranging in length from 1-1/32 to 1-3/32 inches. Each of these bales was separated into at least 10 uniform spinning test lots and spun into 20s, 30s, and 40s carded warp yarns. Ten lots of each bale were given the same picker treatment and five of them were carded with a cylinder speed of 168 r.p.m. and with doffer speeds of 8, 10, 12, 14, and 16 r.p.m. The other five were carded at a cylinder speed of 199 r.p.m. and with the same series of doffer speeds. As doffer speeds were increased there was a proportionate increase in the speed of the feed roll and the production per hour. At both cylinder speeds the number of neps in the card web rapidly increased and yarns became poorer in appearance as doffer speeds were progressively increased. With a cylinder speed of 168 r.p.m., the first significant decrease in appearance occurred when the doffer speed was increased from 10 to 12 r.p.m., while with the cylinder running at 199 r.p.m. the first significant decrease was found when the doffer speed was increased from 12 to 14 r.p.m.

Yarns became progressively poorer in appearance, and card web neppiness was increased to a greater extent by using lower grades of cotton than by greater doffer speeds. These results demonstrate the necessity for higher grades when good appearance is essential, even though some improvement may be effected by slower carding or by faster card cylinder and licker-in speeds. Higher card cylinder and licker-in speeds were found most beneficial to yarn appearance when

productions of about 12 or more pounds per hour were being run. This, of course, applies only to cottons having approximately the same staple lengths as those in this test. The quality of yarns spun from a lap of Middling Gray given more than normal beating in the pickers showed no improvement above normal picker treatment.

Yarn skein strength tests made on three counts of yarn from each of the 53 spinning test lots showed that the strongest yarns were made from the Low Middling bale, followed in order by Good Middling, Low Middling Bright, Middling Spot (light), and Middling Gray. Yarn strength differences found are probably attributable to differences in fiber length and other properties rather than to grade alone.

Yarn strength was not affected by greater beating in the pickers or by increasing card doffer speeds. Test lots carded at a cylinder speed of 199 r.p.m. were spun into yarns having strengths less than 0.6 percent stronger than those carded at 168 r.p.m., a difference to small to be of practical significance. With the exception of badly weather-damaged cotton such as the Middling Gray in this test, the results indicate that lower grades may be substituted for higher grades without sacrificing yarn strength.

Manufacturing waste was, of course, greater for the lower grades of cotton. The more efficient carding when the cylinder speed was run at 199 r.p.m. is reflected in greater percentages of manufacturing waste. When card production was increased without increasing the cylinder speed, less waste was removed. This difference in waste is accounted for by lighter flat strips and less motes and fly.

Fiber tests were made on each lot to determine length by the array method, fiber tensile strength, percentage of thin-walled fibers and fiber fineness. No significant differences were found between length measurements made on raw cotton and on card sliver from a given test lot.

The large percentage of thin-walled fibers in the Low Middling bale may largely account for its good yarn strength, high degree of neppiness in the card web, and poor yarn appearance.

Manufacturing waste, card web neppiness, and yarn appearance were poorer for those cottons having the greater fiber irregularity as shown by the coefficients of length variability. Coefficients of length variation and percentages of thin-walled fibers showed a definite upward trend for the lower grades.

The manufacturing performance of each lot of cotton was carefully observed as it was being processed. No difficulty was encountered so far as the actual machining was concerned, but the Middling Gray and Low Middling grades made the atmosphere very dusty and uncomfortable. The machinery required about three times as much cleaning after these low grades were run.